

THESIS

PROPAGATION BY BUDDING WITH
SPECIAL REFERENCE TO THE CHERRY

R. C. SIMPSON

1905

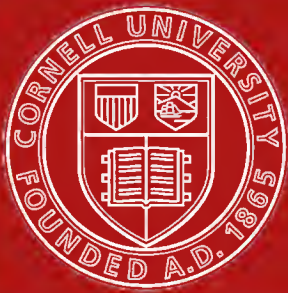
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PROPAGATION BY BUDDING

with

SPECIAL REFERENCE

to the

C H E R R Y

T H E S I S

Submitted for the Degree of

B.S.A.

BY

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C.T.

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PART I.

INTRODUCTION.

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Definition.

Budding is a sub-division of the art of grafting, and in France is more aptly termed bud-grafting. It has been defined by Professor Bailey as "the operation of applying a single bud, bearing little or no wood, to the surface of the growing wood of the stock."

Affinity of Species.

The stock is a growing tree or shrub, and must be closely related, botanically, to the bud applied. Just how close this relation must be differs with different plants. We can say, however, that plants to be united must at least be of the same botanic family. As a rule, the closer this relation, the greater is the likelihood of obtaining a union. Varieties of the same species will almost always unite readily; and different species of the same genus will also usually form a good union, but their affinity can by no means be depended upon. One species may take well on another, yet the latter when used for budding purposes may not unite on the former. This is admirably illustrated by the Mahaleb cherry. All the species of cherry unite with *Prunus Mahaleb*, but the latter will not succeed on any of them.¹ Differ-

¹ See Baltet's "L'Art de Greffer," p.3.

ent genera sometimes unite but it is not a common occurrence. It is evident, therefore, that no laws governing affinity between species are known.

Budding vs. Grafting.

One cannot always say just what plants should be grafted and what ones budded, since many can be propagated by both operations. Generally, however, a plant can be multiplied more successfully by one method than by the other. Sappy plants, especially if their bark is thin, usually succeed better when grafted. Most fruit trees--practically all stone fruits--are propagated by budding. The apple, however, grows equally well when grafted, and in the West at least, is generally so multiplied. The question has often been raised as to whether a grafted apple tree is as good as a budded one. Despite many statements to the contrary, experience has shown that when the operation is properly done, one method is as efficient as the other. It is usually more economical to the nurseryman however, to grow grafted trees, since the grafting can be done in the winter when his men are not so busy. In top-working, until recently, grafting has been the prevailing practice, but at present top-budding is recommended if the tree is not too large. Plate I shows a young orchard tree that was top-budded the previous summer.



PLATE I.

YOUNG ORCHARD TREE WHICH HAS BEEN TOP BUDDED;
THE BUDS ARE JUST STARTING TO GROW.



PLATE II.

SAME AS PLATE I, EXCEPT ONE BRANCH OF THE TREE
WAS LEFT FOR BIRDS TO ALIGHT ON, THUS
PROTECTING THE TENDER YOUNG SHOOTS
FROM THE POSSIBILITY OF BEING
BROKEN DOWN.

Season for Budding.

Budding may be practiced to a very limited extent in the spring, but is usually done in the late summer and early fall, the season usually extending from the latter part of July to September. During this period the stocks attain the proper size, and mature buds can be procured. For the best results the stocks should be growing nicely, but not too rapidly. If they are not growing fast enough, the bark will not lift readily, and, on the other hand, if they are making too much growth and the sap is very plentiful, the bud is likely to be "strangled." If the sap wets the outer bark around the cut to any extent when an incision is made, one had better wait until growth is checked somewhat.

Plant Union.

It is best to unite plants of ^{equal} mutual vigor, hardiness, and of like condition of sap. If one is a more vigorous grower than the other, it should be the bud, as such a relation tends to check the growth of the tree and promotes fruit production. Familiar proofs of this statement are the pear budded on quince roots, and the cherry on Mahaleb. When the sap of the two plants is not in the same condition it is better to have the stock in a more advanced stage. When all the conditions are favorable, however, the success or failure of the operation depends to a very great extent on the skill of the operator. To become a skillful budder requires

many long days of practice and experience.

Fruit Stocks.

Most stocks are obtained from seed, though some are grown by layering, and some by cuttings. Those coming from seed are usually not large enough to work until the second year. The first season they are planted in seed beds, and in the spring of the next year are transplanted in nursery rows. This work is done with a dibble or a spade, the latter implement usually being preferable, though more costly. Before planting, the roots (and tops of some plants) should be trimmed and well puddled. The soil must then be securely packed around the roots of each. Many thousands of stocks die annually because they are loosely planted. The nursery rows average about three and a half feet apart, and the plants in the rows vary from one to twenty inches. Eight inches is the most common distance, however, but the kind of stock and the quality of soil make different spaces necessary. Peach stocks on good soil may be almost touching each other and yet attain a normal growth. Moreover, since they also grow exceptionally rapid, the seed may be sown in the nursery row in the fall, and the stocks budded the following summer. Many of our stocks, as the Mahaleb and Mazzard cherries, Myrobalan plum, and pear seedlings, are chiefly imported from France and Germany. Mahaleb are now being grown in Kansas to some extent, but they are not so satisfactory as the French grown. They are usually higher



PLATE III.
YOUNG PEACH SEEDLINGS JUST COMING UP.

priced, larger than necessary, low and thickly branched, and with thicker, tougher, and tighter bark. The low branches are in the way of the bud, and the thick, tough bark makes the insertion of the bud more difficult.

Cherry Stocks.

For cherry stocks Nurserymen have a larger choice than for most other trees. The Mahaleb (*Prunus Mahaleb*), Mazzard (*Prunus Avium*) and the Sour Cherry (*Prunus Cerasus*) or ordinary Morellos may be used. In the Northeast the Bird Cherry (*Prunus Pennsylvanica*), and in the Northwest the Sand Cherries (*Prunus Pumila* and *Prunus Besseyi*) are also used to a very limited extent. The Mazzard is perhaps the best stock--at least from the orchardists' standpoint. It is a free grower, producing a single upright stem, and is especially well adapted to the vigorous sweet cherries. As a matter of fact, however, the Mazzard is little used by nurserymen, since it is very subject to leaf blight and to serious attacks of black aphid, causing arrest of growth, and the setting of the bark before the budding season has well begun. I have heard some nurserymen say that they would not plant Mazzard stocks if they were given to them. The Mahaleb is the nurseryman's favorite, and upon it most cherries are worked. It is not such a free grower as the Mazzard, but it answers the purpose very well. It grows well, admits of a long budding season, peels easily, unites readily, and is little troubled by leaf blight



PLATE IV.
BLOCK OF MAHALEB STOCKS.



PLATE V.
VIEW SHOWING A 10% STAND OF CHERRY
ON MORELLO STOCKS.

or aphid. The Mahaleb tends to dwarf the tree to a slight extent, but this tendency promotes greater fruit production. The other stocks mentioned are little used, most of them either peeling poorly, suckering badly, or forming a poor and uncertain union.

Growth of Stocks.

The stocks should be kept growing as rapidly as possible by frequent cultivations--once every ten or twelve days is a good average. If the soil is comparatively clear of weeds, and proper cultivation is given, little hand hoeing will be necessary. The spraying also should not be neglected. In fact, I believe, the spraying of cherry and pear stocks at least, is just as important as the spraying of the budded trees. Usually Bordeaux mixture is all that it is necessary to use, but occasionally some soap solution or tobacco water may have to be applied in spots, if aphid makes an appearance. It is seldom, however, that this pest attacks Mahaleb stocks.

Selecting and Preparing the Buds.

In selecting the "bud sticks" or branches from which the buds are to be cut, great care must be exercised. Only shoots of the present season's growth are used, and these ought to be of well matured wood. They should also be healthy, of good quality, and preferably taken from a thrifty tree of well known value. In the nursery row the upper branches of the trees usually furnish much



PLATE VI.

DISC CULTIVATOR--ESPECIALLY WELL ADAPTED FOR
THE FIRST CULTIVATION OF BUDS IN WEEDY
GROUND; IN STONY SOIL HOWEVER,
IT IS USELESS.



PLATE VII.

A GOOD TYPE OF CULTIVATOR FOR NURSERY WORK.



PLATE VIII.

A GOOD TYPE OF CULTIVATOR FOR HIGH TREES.

better wood for budding purposes than the lower ones. As soon as the sticks are cut from the tree, the leaves must be cut off, leaving only about one-fourth of an inch of the petiole to serve as a handle to the bud. It is very important that the leaves be cut off immediately, as otherwise much moisture is lost from the stick. Since the tips of the sticks are usually too succulent to be used, they are also cut off at this time. When a few hundred sticks are cut and trimmed, they are dampened and wrapped in a wet cloth, and left in some cool, shady place until ready to be used in the bud patch. This work should be done by some one directly interested in the welfare of the firm, since it requires much good judgement, and since all the different varieties of each kind must be kept separated. The sticks may be trimmed, however, by any careful boy.

Fresh Buds Desirable.

For the best success buds should not be used which are over twenty four hours old, though often fair stands are obtained when they have been cut several days or even a week. As a rule, however, the fresher the buds, the better will be the stand. One should never buy buds away from home unless it is absolutely necessary, since they are never so fresh, are often bruised in shipment, and occasionally not well packed. They can be sent in comparative safety, however, for reasonable distances when packed in a wooden box. Often fifty per cent of buds not boxed are bruised and ruined in transit.



a

b

PLATE IX.

BUD STICKS WITH LEAVES STILL ON; (A) STICK
FROM TWO-YEAR-OLD TREE; (B) STICK
FROM ONE-YEAR-OLD TREE.



a

b

c

PLATE X.

BUD STICKS TRIMMED; (A) STICK FROM TWO-
YEAR-OLD TREES; (B) SAME, FROM
WHICH LEAVES HAD FALLEN;
(C) STICK FROM ONE-
YEAR-OLD TREE.

Budder's Equipment.

The budder's equipment consists of a budding knife, a stone and a strap for sharpening it, a "sack" or piece of cloth to wrap his bud sticks in, and usually some sort of pad or box to sit upon. The knife blade should be of the best steel, thin, narrow, and curved backward at the point. The end of the handle usually holds a spatula made of bone or ivory, which is supposed to be used for raising the bark, but which is seldom done, as the point of the knife serves the purpose better. Several styles of knives are shown in plate XI. The knife should be kept very sharp--sharp enough to shave--and, since it is fitted only for delicate work, should be used for nothing else. The bud sticks are wrapped up in the sack--a piece of old carpet makes an excellent one--so that only the butts are visible, and are then slung on the back of the budder. Thus, as one stick at a time is being used, the remainder are kept well protected from evaporation. A budder may carry enough buds to last him two hours or even longer if the weather is cool or cloudy.

Preparing the Stocks.

The cultivation should always have made a ridge of at least two inches along the row, and before any buds are inserted this dirt must be cleaned away from the base of the stocks until the ground is level. The side of the tree which is to receive the bud should also be cleaned with some sort of a brush, but in so doing one must



PLATE XI.

DIFFERENT TYPES OF BUDDING KNIVES, RANGING
IN PRICE FROM 15¢ TO \$1.00.



PLATE XII.
BUDDER, READY FOR WORK.

be careful not to bruise the tender bark. If the stocks are not thoroughly cleaned, dirt may fall into the cut and prevent the union of the bud. Stocks always peel better where the damp earth has been removed. One man can clean away for two or three budders, and also have time enough to carry water for the rest of the workmen.

Shield Budding.

Now comes the all important question, "How is the operation performed?" To start with we may say that there are four or five methods of budding, but most of these are modifications ~~are modifi-~~
~~cations~~ of one main type, or are unimportant and little used. I shall describe only the method commonly used by nurserymen, which is known as shield budding.

Shield budding, though often modified in minor details, consists of removing the dormant bud from the stick and inserting it beneath the bark of the stock. The budder draws out a stick from his sack with his right hand, grasps it with his left, the butt of the stick pointing away from him, and assumes the position shown in plate XIII. He is now ready to cut the bud. The knife blade is inserted from one fourth to one half an inch above the bud as far as the wood, then carried along just between the bark and the wood until it has passed under the bud and from one half to three fourths of an inch beyond. It is then easily removed from the stick by a



PLATE XIII.
CUTTING THE BUD.

slight up-turning of the blade. To cut an ideal bud the knife should go only as far as the alburnum, severing all the bark, but removing none of the wood. The bud should not be cut by merely pulling the knife straight back, but by a sliding movement of the blade. One should start the cut near the heel of the knife blade (see plate XIII), and end it near the point. With many plants, however, it is often very difficult to remove the bud without leaving a bit of wood just under the bud. This is usually so small, though, that its presence is immaterial, but occasionally on some sorts, it is necessary to make a slight turning movement of the knife over the hump just under the bud. Buds cut a very little bit thicker or thinner than described generally live very well, yet their chances must be somewhat lessened.

The Matrix.

The opening in the stock is made by two cuts, one horizontal and the other vertical, at right angles to each other in the shape of the letter T. These cuts should extend only through the bark, yet if they go a little further no harm is done. Either one may be made first, but unless the bark slips very freely, it is best to start with the transverse cut. This is done with the point of the knife with one rocking motion. The bud can be inserted more readily if the cut slopes downward through the bark toward the wood. The vertical cut is now made---also with the point of the knife---



PLATE XIV.
(b) BUD ENTERING MATRIX;
(a) BUD INSERTED.

by starting from one to one and a half inches below the other incision, and drawing the blade up until the two meet. Then the bark is raised by a deft twist of the knife to the left and right, and the point of the bud inserted with the left hand into the opening. (plate XIV.) The leaf-stem is now grasped with the tip of the thumb and forefinger of the right hand, and pushed home. The thumb-nail plays an important part in this operation and should be comparatively long and stout. If the leaf-stem has fallen off the bud may be pushed in by the point of the knife, the pressure being applied at the leaf scar. This requires considerable care, however, since the knife point may injure the bud, and should not be practiced unless buds are scarce. When the bud is put in care should be taken that no dirt or other foreign material falls into the cut. If the stocks do not peel well it is often necessary to open the bark for the entire length of the cut. Moreover, when the bark is very tight, it is sometimes necessary to raise the bark by means of a quill, before the bud can be inserted. Such conditions, however, greatly reduce the chances of success, and need not be taken into account when stocks are well tended and budded at the proper time.

Inverted Budding.

Occasionally when the sap in cherry stocks is flowing very freely, the bud is inserted from below upward, thus lessening the chances of smothering the bud. In this case the transverse cut is

made at the bottom, and the wound takes the shape of an inverted T. Of course, only the manner of insertion is reversed, the bud itself remaining in an upright position. In this method the bud must be cut from the opposite direction to that described above, since the point of the bud must be on the other end. This style of budding is sometimes used to a considerable extent on maple and orange trees, which often have a superabundance of sap. This is also the prevailing method used by nurserymen at Dansville, New York.

Speed an Important Item.

In nurseries, the speed of a budder is an important consideration, but by no means deserves the prominence sometimes given it. Quality of work should always come first; speed second. The mistake usually made by the beginner is to go too fast. He wants to become a swift budder, and slights his work in consequence. This is disastrous to the nurseryman, as the work must then be gone over again. Budders should first learn exactly how the work is done, and let the speed come later. An experienced budder, when conditions are favorable, can bud 2,000 trees in a day. Many can do more than this, some putting in 3,000 or 4,000, and occasionally as high as 5,000 in one day. At the last meeting of the Nurseryman's Association (1904) there was a man present who claimed to have budded 8,000 stocks in one day! There are more workmen, however, who average less than

2,000 than there are that average above that figure.

Tying the Bud.

As soon as the bud has been inserted it must be tied. Several different kinds of ligatures are in use. The ideal tying material should be strong, pliable, elastic, cheap, easy to handle, and unaffected by varying moisture conditions. Woolen thread or yarn has many of these qualities, but is hardly strong enough, and, moreover, is too expensive for extended use. Bass-bark and raffia are also much used, the latter to a greater extent than the former. When raffia was first introduced it was very cheap, but at present is more expensive, yet in the United States it is used more than any other tying material. Its chief defects are its habit of rolling when it becomes dry, and its susceptibility to hygrometric influences. The first difficulty can be overcome by wetting and beating it out before using, though this takes some time and trouble. The second and principal defect, however, cannot be remedied. Carpet warp is now used to a considerable extent by nurserymen, and, in my opinion, is the best all around ligature yet found. It is strong, pliable, easy to handle, requires no preparation, only slightly more costly than raffia, and is not affected by moisture. Its only defect is its inelasticity, which, however, is not absolutely necessary, since the bandage can be removed after the bud has set and before the stock becomes seriously injured.



a

b

PLATE XV.
THE BUD TIED; (A) WITH CARPET WARP,
(B) WITH RAFFIA.

The tying is usually done by a boy who follows closely behind the bulder. It is important that he does not lag behind, since if much time is lost between the insertion of the bud and the application of the string, it may die from the injurious effects of the atmosphere. The tier generally sits flat on the ground while at work, and often keeps one leg across the row. The bandage is wrapped around the tree in a spiral manner, commencing a little below the bottom of the cut as shown in plate XV. One end is secured by passing the first course over it, and the other by a simple loop at, or a little above the top of the wound. Each wrap of the string should be drawn tight enough so that none are moved by passing the finger over them. On the other hand, however, they should not be drawn tight enough to bruise or cut the bark. Usually the chief difficulty with a tier is to have him wind tight enough, since by continual wrapping, his fingers often become tender. It is sometimes necessary for one or more fingers to be protected by some material such as a piece of thin leather, until they become toughened to the work. If carpet warp is used for the tying material, at least three or four wraps should be made below the bud and four or five above, leaving about one eighth of an inch between courses. Care should be exercised that the string be wound as straight as possible around the tree, as otherwise it may work loose. The wraps just above and just below the bud should be as close to the bud as

possible without touching it. Under no circumstances should the string be allowed to touch or tie down the bud. When raffia is used fewer wraps are necessary since this bandage is much wider than the carpet warp. One good tier can usually keep up with a budder, but it is sometimes necessary to put two after a very fast operator. In the arid and semi-arid regions of the West, carpet warp cannot be used to advantage, since too much of the wound is left exposed to the dry atmosphere. In such places bass-bark or raffia is imperative, but for the humid regions of the East and Middle West carpet warp is recommended.

String-cutting.

About two weeks after budding the bandage must be cut or the stock will become girdled ^{by the continued growth of the stock.} This ^{is} done by a single stroke of a knife across the strings on the side opposite the bud. The thumb or finger is then rubbed across the severed strings which drop to the ground. The string cutter to accomplish as much work as possible, should straddle the row, bend over to perform the operation, and walk backwards down the row. By going backward the stocks are bent over by the body in the proper position to cut, and considerable time is thereby saved. A good knife is not so essential for this work, but the better it holds edge, the easier and faster the work can be done. Almost any shaped knife blade will suffice, but a stiff bladed budding knife answers especially well. In cutting

off the bandages it is very essential that all the courses of string be cut, as otherwise the tree will be girdled, and the top may be blown off by the wind. Care must also be exercised that no stocks are missed. It is very essential that the string be cut at the proper time, for if one waits too long it becomes imbedded in the bark of the stock and much time is lost in picking it out. Moreover, the stock is weakened and its growth checked by the consequent girdling.

Rebudding.

After the strings have been cut, we can go over the stocks and rebud what have failed, and also those that were too small at the first budding. If a good stand is obtained at first and few small trees are left, many nurserymen do not go over the stocks the second time. This is especially true of the cheaper class of trees, such as the peach and the apple. Among the higher priced stocks, however, such as the cherry, pear, and plum, even if an excellent stand has been secured, it will always pay to rebud, if the workmen are not needed worse somewhere else.

It is often difficult to distinguish a live bud from a dead one, until one has had considerable experience in examining them. One who has done considerable rebudding, however, can generally tell a dead bud at a glance. If a doubtful bud is not discolored, withered, or partly separated from the stock, it may be necessary to "feel" it.

The finger is pressed lightly against the bud, and if it is slightly elastic or springy it is generally alive; if it is stiff and hard it is usually dead. If the first budding has resulted in a poor stand, the rebudding is done in the same manner as the first operation, i.e., the budder and tier pass each tree as usual and put in a bud wherever one is needed. If the greater per cent of the buds have lived, the budder (and the tier also if he can be trusted) first goes along the row and marks the stocks which have failed, and then passes rapidly back and buds those which are marked. In this manner much time is saved, especially if the tier is also competent to examine the buds. The new bud is usually placed just above or just below the dead one, the latter position being preferred if there is room enough, since the dead bud will then be cut away with the top of the stock. If carpet warp has been used for tying, it sometimes pays to have a boy go ahead of the budder and remove the string, since the upper strands often remain loosely hanging on the bud. Occasionally, when there has been a very poor stand, and it does not pay to examine what are alive, each tree is rebudded on the other side.

Pruning the Stocks.

Early next spring, before growth starts, the stocks must be cut off above the bud. Just how this should be done is a question of considerable importance, yet one that has not received sufficient attention. In some parts of New York, I understand, it is customary



PLATE XVI.

THE STUB ON THIS TREE WAS LEFT ENTIRELY
TOO LONG WHEN THE STOCK WAS CUT.

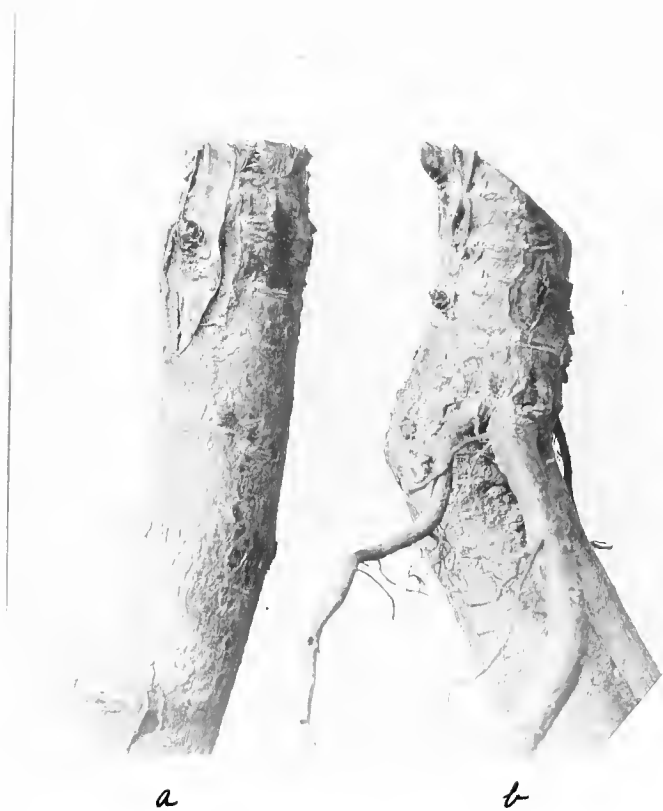


PLATE XVII.
STOCKS CUT OFF; (A) THE USUAL WAY,
(B) THE BETTER WAY.

to make two cuttings--the first removing about half of the top of the stock and the second taking the remainder. In most places, however, only one cutting is necessary, and the sooner this is made after spring begins to open, the better.

Most nurserymen cut off the stocks nearly parallel with the ground, at, or a little above the top shield of the bud. (plate XVIIa) If the tops are cut off higher than this an unsightly stub is left (plate XVI). When they are cut square off, even at the top of the shield as shown in plate XVII a, several years growth is required for the wound to be completely healed over. If they are cut off at the same place with a sloping cut they heal more rapidly. Few nurserymen, however, ever cut into the shield itself, yet, I am confident, that here is the proper place. Remove the stocks with a slanting cut as close to the bud as possible (plate XVII b) without touching it. This, of course, will remove most of the top shield. I have seen trees cut off in this manner heal over completely during the first seasons growth! And I have seen few, indeed, which were not healed the following season. Moreover, stocks so cut off will form a smaller crook at the bud, and therefore make a straight^{er} and more shapely tree. (plates XVIII, XIX.)

Yet the questions are at once raised, "Will not buds cut so close 'dry out' or be much more easily blown down by wind?" These objections certainly seem reasonable, yet, in Indiana at least, experience does not prove ~~it to be so.~~ ^{them to be well founded.} From what observations I



a b c

PLATE XVIII.

(A, C) TREES WHICH WERE CUT OFF AS THEY SHOULD BE;
(B) TREE WHICH WAS NOT CUT OFF CLOSE ENOUGH
TO THE BUD. NOTE THE DIFFERENCE BE-
TWEEN THE CROOKS OF (A, C)
AND THAT OF (B).



c b a

PLATE XIX.

SAME TREES AS SHOWN IN PLATE XVIII, TAKEN FROM THE
OTHER SIDE, SHOWING THE WOUNDS OF (A, C) AL-
MOST HEALED OVER, AND THAT OF (B) NOT
YET HEALED AT ALL. THESE TREES
ARE JUST STARTING ON THEIR
SECOND YEARS GROWTH.



PLATE XX.
DORMANT BUDS.

have made, I have never been able to see that it made any difference at all. I am sure the buds do not dry out, because the stands are no better when cut off higher up. Moreover, I have seen blocks of hundreds of thousands of trees cut off in this manner, with only a few scattering ones blown down during the entire season. In fact, I have never seen many blown down in any season, although we occasionally have some very respectable wind storms. Therefore I feel confident in recommending that stocks be headed by a slanting cut made as close to the bud as possible.

Training the Buds.

Soon after the buds have started to grow they must be "suckered" i.e. all sprouts growing from the stocks must be rubbed off. This should be done at the proper time, or they will soon become so large that a knife will be necessary to remove them. (Plate XXI.) Cherry trees rarely need to be suckered more than once, but some stocks, as the peach, must be gone over at least twice. (In suckering one must be very careful not to rub off the bud itself.) One should never wear gloves at this work, since their presence interferes with the work and increases the chances of knocking out buds.

Growth of Buds.

All the food gathered by the roots of the stock is now thrown into the single bud, which makes a rapid growth, and soon assumes the appearance of a tree. Peach buds, especially, grow very fast,



PLATE XXI.

SUCKERING PLUM. NOTE THE NUMBER AND HEIGHT OF
THE SUCKERS. THIS WORK SHOULD HAVE BEEN
DONE A WEEK OR TWO EARLIER.



PLATE XXII.
SUCKERING CHERRY.



PLATE XXIII.
BLOCK OF PLUM BUDS. NOTE METHOD
OF SUPPORT.

being ready for sale after one season's growth. Most other fruits, however, are not put on the market till two or three years old. It is usually necessary to give young plum buds some kind of support to keep the wind from blowing them down. This may be done by stretching wires and strings along the row as shown in plate XXIII, or by staking each separate shoot. The latter method costs a little more, but it is to be preferred, since the wires chafe the trees to a considerable extent. Most fruit buds, however, require no such support.

Controlling Diseases.

Spraying has come to be ^avery essential factor in the nursery business, especially in growing cherry and pear. In fact, cherry trees that formerly could never be grown to a salable size before two years old, can now, under favorable conditions, be put on the market after one season's growth. Few nurserymen, however, have yet learned to do this successfully. The great enemy of the young cherry tree is the powdery mildew, which checks the growth by causing the leaves to roll up and drop off prematurely. This can be effectually prevented by frequent applications of Bordeaux mixture. The fungus chiefly attacks the under side of the leaves, and the spray must therefore be applied so as to reach that part; otherwise little good is accomplished. A good style of nursery sprayer is shown in operation in plate XXVII. This machine can spray from three to six rows at a time, and will put an evenly



PLATE XXIV.
GENERAL VIEW OF BLOCK OF YOUNG
CHERRY BUDS.



PLATE XXV.
A BLOCK OF PEACH BUDS.



PLATE XXVI.

TWO ROWS OF CHERRY BUDS; (A) TREES BUDDING
ON MEDIUM SIZED STOCKS; (B) TREES
BUDDING ON LARGE STOCKS.

distributed mist on the under side of the leaves. Since whatever goes up must come down, the tops of the leaves are also well sprayed. With an outfit like this half a dozen sprayings can be given during the growing season at comparatively small cost. A good stocky 4 to 5 foot one-year-old cherry tree grown in this manner is preferred by many to the lanky 5 to 6 foot two-year-old tree. Spraying alone, however, will not grow salable one-year cherry trees. Yet if the climate is right, a good strong clay loam soil available, proper pruning understood, and the best of tillage given, spraying will do the rest.



PLATE XXVII.
A NURSERY SPRAYER IN OPERATION.

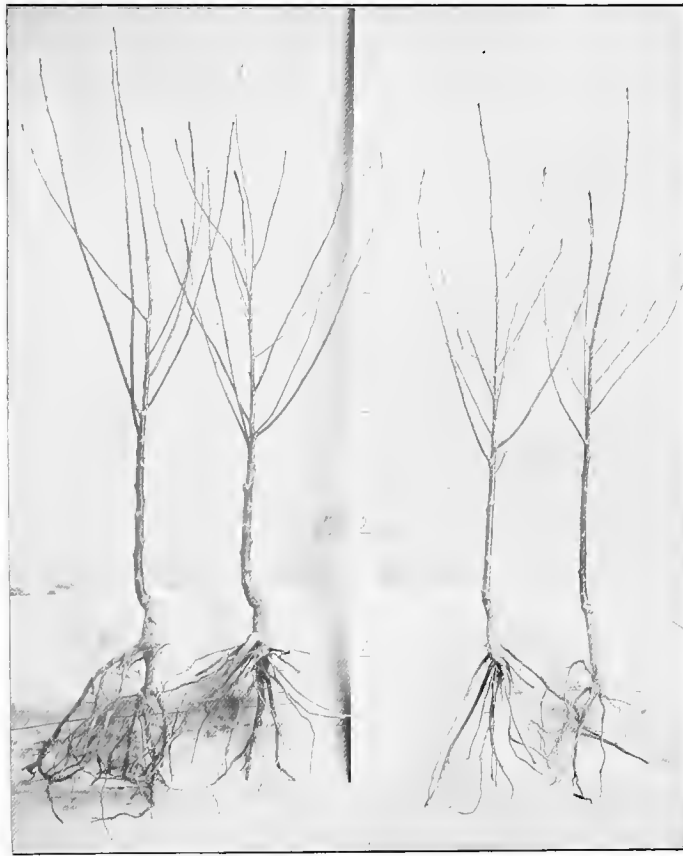


PLATE XXVIII.
MIXING TANK FOR MAKING BORDEAUX.



PLATE XXIX.

VIEW OF AN ESPECIALLY FINE ROW OF TWO-
YEAR-OLD CHERRY TREES.



No. 1.

No. 2.

PLATE XXX.

A SAMPLE OF THE TWO UPPER GRADES OF ONE-YEAR-OLD
CHERRY TREES GROWN BY A FIRM IN SOUTHERN INDIANA.

PART II.

EXPERIMENTS.

Purpose of Experiments.

The frequent poor stands of buds obtained by nurserymen, especially with cherry stocks, suggested to me the idea of trying to ascertain to what cause or causes this was due. The experiments described here were carried on in a nursery in the southern part of Indiana. A block of Mahaleb stocks which was a part of a larger block of trees, and which was subject to all the actual nursery conditions, was selected for the work in hand. To simplify this problem as much as possible only one variety--early Richmond--of buds was used in all the experiments except number 9.

The work was divided into nine main divisions to determine:

1. The influence of temperature on the setting of buds.
2. The best method of cutting the buds.
3. The influence of methods of cultivating the stocks.
4. The influence of the checking of sap by cutting off the tips of the stocks before inserting the buds.
5. Which buds on the stick are best to use.
6. Influence of aspect.
7. Influence of age of bud.
8. The best kind of tying material.
9. The effect of mounding up the buds during the winter.



PLATE XXXI.

GENERAL VIEW OF THE EXPERIMENTAL BLOCK.

IT EXTENDS ONLY PART WAY DOWN
THIS FIELD.



PLATE XXXII.
ANOTHER VIEW OF THE SAME.

I. Temperature.

It has often been noticed by nurserymen that some years they secure very good stands of buds, and other years very poor. Again, buds put in during one part of the season live well, while those inserted at another time do poorly. Temperature has been designated as one of the chief causes of this fluctuation, most nurserymen claiming that a poor stand is caused by hot weather, especially if it is sultry at the same time.

To determine, if possible, the extent to which temperature influenced the setting of buds, two rows (numbers 4 and 5) of the experimental block, were selected and ten buds were set in each row almost every day for a period of more than a month. The buds on one row, (no. 5) were cut with a little wood, (see exp. II, 4) and those on the other row (no. 4) without any wood but with all the bark, (see exp. II, 1).

Thermometers were hung in the field as follows: no.1 in the air about twelve inches from the soil; no.2 with the bulb well into uncultivated ground; no.3 with the bulb in soil that was being cultivated (row no.1). A fourth was hung about four feet from the ground in the lawn under the shade of three large maple trees. Each of those in the field were shaded by a strawberry crate lid 8 x 22 inches. Maximum and minimum readings were taken daily, and the kind of weather and conditions of sap noted. These observations are given in tabulated form below:

Aug.	No. 1.		No. 2.		No. 3.		No. 4.		Weather	Condition of sap.
	Field max	air min	Uncul. max	soil min	Cult. max	soil min	Maple max	shade min		
3	*94.5	61.5	*84	67			81		part cloudy	normal
4	93	61	83	68	89	65	84	65	clear	"
5	95	67	82	72	86	70.5	82	69	pt. cl., hazy	"
6	91	59	79	68	81.5	67	82	65	hazy	"
7	91.5	54	79	67	81	66	81	62	"	(Sunday)
8	89	56	*81	66	*85	65	75	57	clear	normal
9	93.5	59.5	78	66.5	82	66	83	60	part cloudy	"
10	93.5	68	80	72	83.5	71.5	83	70	rain 1.5 in. 4PM.	"
11	86	63	78	67	80	67	77	64	clear	free

17, at first sight, also appears to be an exception to the general condition, since a 95% stand was secured on that day in this experiment.

As seen from the table just given, the thermometers hanging in the shade of the maple trees at no time went above 89°, and most of the season hovered close to 80°. We were not therefore surprised when little or no connection was found to exist between the temperature and the stand of buds obtained for that season. From the accompanying chart of ~~the~~ rows it is seen that equally good stands were secured on warm and cool days. The averages of the four thermometers for the month of August give us a good idea of the differences of temperature we may expect to find between what we usually call "in the shade" (no. 4), and that in the field (no. 1). The readings also show us that there is a very appreciable difference between the temperature of cultivated and uncultivated soil.

From the results of this experiment it seems that rain has an injurious effect on the stand of buds set the same day, and possibly on those inserted the day previous. Every day that rain fell, when any budding was done (Aug. 10, 18, 20, Sept. 2, 13, 17) a comparatively poor percentage of buds lived. moreover, with but one exception, the lowest stands recorded were secured on days when rain fell. It is also worthy of note that this exception (Aug. 9) was on a day just previous to a very heavy and dashing rain. September 17, at first sight, also appears to be an exception to the general condition, since a 95% stand was secured on that day in this experiment

It should be noticed, however, that the stand obtained on the same day, on the same rows, in experiment VI was only 68%. Therefore it seems very probable that, at least for the day on which it falls, rain does lessen the chances of securing a good stand of buds.

It will also be noticed from the chart, that Row 4, which contained only "ideal" buds (see experiment II, 1) averaged almost 5% better than Row 5, which contained buds with a thin shaving of wood. This shows that buds without any wood, providing they have all the bark, are to be preferred to those with a little wood.

As this experiment was being performed, the first five of the ten buds set each day, were taken from the tip half of the stick, and the second five from the butt end. There was a difference of about 2% in favor of those taken from the smaller end of the stick.

The following table sums up some of these results:

	Number budded	Number alive	%	No. alive from tip half of stick	%	No. alive from butt half of stick	%
Row 4 (ideal buds)	240	210	87.50	106	88.33	104	86.66
Row 5 (buds with little wood)	240	199	82.92	101	84.17	98	81.66

II. Cutting the Buds.

General Propositions.

Poor stands of buds are often attributed to the way in which they are cut i.e. as to their relative thickness or thinness, etc. I have previously described the method which is usually considered the best, yet, so far as I know, it has never been proved, experimentally, with cherry buds. At least many minor points are still moot ground. Should a bud be cut with a very little wood, or with a considerable amount; or, on the other hand, should it have any wood at all? Should the bud have a short, medium, or long point? Is the top part of the shield necessary at all? May a cherry bud be "^hsuckered" i.e. have the wood torn out, as peach is treated? Is it necessary in cutting the bud to make a sliding cut with the knife, or will a straight cut do equally well? These and similar questions are constantly coming up to the mind of the budder. These experiments ^{were} were undertaken to try and answer some of these questions.

Experiments.

Row no. 6 was selected for this purpose. The buds--ten of each kind--were cut in twelve different ways:

1. Ideal buds--those which I considered as ideal, and which contained no wood but had all the bark. (Plate XXXIII, c)

2. Thinner buds--those which did not contain all the bark i.e. the knife did not quite penetrate to the wood of the stick (Plate XXXIII, d)

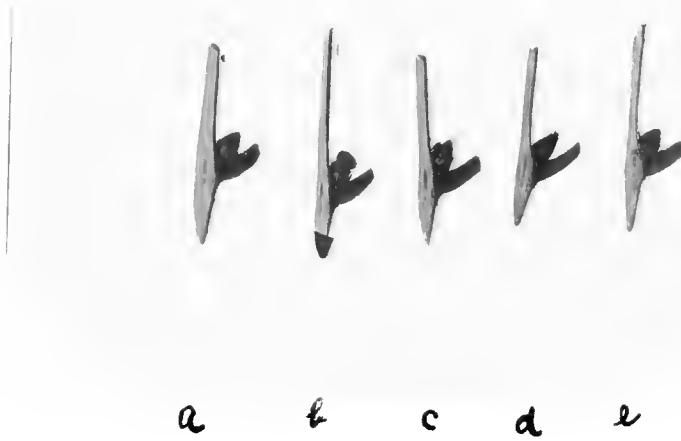


PLATE XXXIII.
BUDS OF DIFFERENT THICKNESS; (A) BUD WITH MUCH WOOD;
(B) BUD WITH LITTLE WOOD; (C) IDEAL BUD; (D)
THINNER THAN C; (E) VERY THIN.

3. Very thin buds--thinner than no. 2, the black crescent behind the bud showing plainly, and which no budder would ever think of putting in. (Plate XXXIII, e).

4. Buds with little wood--containing only a thin shaving of wood, yet thicker than no. 1. (Plate XXXIII, b)

5. Very thick buds--considerably thicker than no. 4, and containing much more wood than any careful budder would allow. (Plate XXXIII, a)

6. Check--buds cut as I ordinarily bud i.e. keeping no. 1 in mind as the ideal, yet varying slightly each way.

7. Sliding cut--buds cut with a sliding movement of the knife, starting as shown in plate XIII. This is considered preferable to the straight cut since it is a well known fact that a cut made in this manner is smoother than one made by merely pulling the knife.

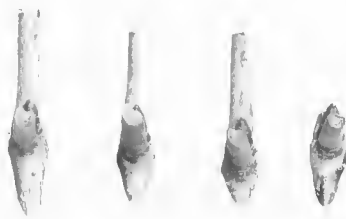
8. Straight cut--buds cut by pulling the knife blade straight back.

9. Short point--buds cut with a short point as shown in plate XXXIV c.

10. Long point--buds cut with an extra long point as shown in plate XXXIV a.

11. Top of shield cut off--buds which had the entire top of the shield cut off just above the bud proper. (Plate XXXIV. d)

12. Shucked--buds that were cut deeper and then had the wood



a b c d

PLATE XXXIV.

(A) BUD WITH LONG POINT; (B) MEDIUM POINT;
(C) SHORT POINT; (D) TOP SHIELD CUT OFF.

torn out. This, of course, would be practiced only early in the season when there is plenty of sap in the sticks.

The most important subdivisions of this experiment--nos. 1, 2, 3, 4, 5, and 6, were worked on at two different dates.

Results.

	First Budding, Aug. 6.	% alive.
1 Ideal buds		80
2 Thinner buds		90
3 Very thin buds		80
4 Buds with little wood		100
5 Very thick buds		90
6 Check		100
7 Sliding cut		100
8 Straight cut		90
9 Short point		90
10 Long point		90
11 Top of shield cut off		30
12 Shucked		80

Second Budding, Sept. 3.

1 Ideal buds	100
2 Thinner buds	80
3 Very thin buds	70
4 Buds with little wood	90
5 Very thick buds	90
6 Check	90

Average

1 Ideal buds	90
2 Thinner buds	85
3 Very thin buds	75
4 Buds with little wood	95
5 Very thick buds	90
6 Check	95

The outcome of sections 1 - 6 of this experiment was a complete surprise. Buds cut thick or thin lived almost equally well, and in no case did the stand go below 70%. This lowest percentage, however, was on the very thin buds; which result might have been expected. 70%, though, is a good catch, and therefore it seems that if other conditions are favorable one need not be so particular in cutting the bud. Yet, on the other hand, since we do not always know when the other conditions are favorable, we had better keep on the safe side. Moreover, the results obtained in the previous experiment from Rows 4 and 5 which represent a full budding season, and are therefore much more reliable, show that "ideal" buds live best. It must also be remembered that the budding season in 1904 was at all times unusually cool and favorable for cherry budding. Therefore we may conclude that buds cut too thin or too thick may, and often do, live just as well as those properly cut; yet, when conditions are not so favorable, the result may and probably will be very different.

In the case of the sliding and straight cut experiments (nos. 7 and 8) there was a slight difference in the number of buds alive in favor of the sliding cut as would be expected. The growth of the buds, however, showed a considerable difference. No. 7, (sliding cut) showed a good normal growth of the greater per cent of the buds. No. 8 (straight cut) exhibited, on the whole, a poor and stunted growth (Plate XXXV.). Only three buds appeared normal, three



PLATE XXXV.
STAND RESULTING FROM BUDS REMOVED
WITH A STRAIGHT CUT.

had just started, and one was making a stunted growth. The remaining two had been broken off, however, so we cannot be sure that it was due to the method of cutting that the remaining four were so stunted, although it seems reasonable that at least this might have been the case.

Sections 9 and 10 showed that the length of the point on the bud had no influence on the stand. Both extra long and extra short pointed buds lived as well as those with an ordinary point. It can be said, however, that it is harder to cut a bud with a short or a long point than one with a medium point. It is also obvious that a bud with a long point would be harder to insert, and more likely to "double up" than one of the usual length.

Section 11 showed striking results, though of no practical value. Only 30% of a stand was secured from buds with the top shields cut off. (Plate XXXIV. d) This seems to show that although the part of the shield above the bud is not in itself essential, yet it must be left on as a protection to the bud from drying out or from winter killing. In the fall all of these buds had apparently taken well, and looked as good as any others. Therefore it would seem that their death was due to winter killing.

Buds which were shucked (no. 12) lived very well, though not so good as those cut in the ordinary way. I think, however, that the care with which this is done has a great deal to do with the result. It may also be said that this method is practicable only

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early in the season when the branches are growing and full of sap.

III. Cultivation.

It is generally believed that the thicker the sap of the stock, provided the bark peels well, the more likely the bud is to live. Therefore it would seem that if the stocks had been well cultivated up to the budding season, and were growing nicely, that it would be best not to cultivate any longer so as to check, to some extent, the flow of sap. It must be remembered, however, that the fungus which attacks the foliage of the Mahaleb often checks the sap, and, of course, it would check it quicker and to a greater extent on stocks that were not being regularly cultivated. This condition might therefore outweigh the seeming advantage of the former. The severity of the disease, however, depends to a large extent on the kind of weather, and on the condition of the stocks i.e. are they vigorous and healthy, and especially have they been kept well sprayed. The fungus can be controlled by spraying, but this is not practiced on stocks so much as it should be.

For this experiment rows 1 and 3 of the experimental block were selected. Both of these rows had been cultivated equally every week or ten days up to July 26, when the cultivation of row 3 was discontinued. The tillage of row 1 was kept up at about the same rate until September 5, five more cultivations being given in all. A few days after each cultivation 25 buds were inserted on row 1, and an

equal number at the same time on row 3 as a check. The detailed operations are given in Chart III.

Results.

		% alive on cul- tivated row.	% alive on row not cultivated.
First budding,	Aug. 6	92	76
Second "	Aug. 13	88	84
Third "	Aug. 31	88	96
Fourth "	Sept. 17	76	88
Average		86	86

As seen from the table, cultivation during the budding season made no difference in the result. It may be worthy of notice, however, that in the cultivated row the percentage decreased from the first of the season to the last, while that of the uncultivated row increased from the beginning to the end of the season, with the exception of the last budding. This might have been due to the fact that the sap in the uncultivated row was getting thicker faster than that in the cultivated row. Toward the end of the season it was noticed that the stocks on the cultivated row peeled considerably better than those on the other row, and therefore the sap in them must have been thinner and the stocks not so well ripened for the winter. The results on each row, however, are so close that they can not be construed to prove anything.

R R R Row 1 Cultivated
 Aug. 3 Aug. 10 Aug. 29 Sept. 15
 Budded
 Aug. 6 Aug. 13 Aug. 31 Sept. 17

Detailed description: A horizontal timeline for Row 1. Above the line, 'Cultivated' is written. Below the line, 'Budded' is written. Dates are marked with 'x' or small squares. Aug. 3 has a square. Aug. 10 has a square. Aug. 29 has a square. Sept. 15 has a square. Aug. 6 has a square. Aug. 13 has a square. Aug. 31 has a square. Sept. 17 has a square.

R R R Row 2

R R R Row 3 Not cultivated
 Budded
 Aug. 6 Aug. 13 Aug. 31 Sept. 17

Detailed description: A horizontal timeline for Row 3. Above the line, 'Not cultivated' is written. Below the line, 'Budded' is written. Dates are marked with 'x' or small squares. Aug. 6 has a square. Aug. 13 has a square. Aug. 31 has a square. Sept. 17 has a square.

IV. Clipping the Stocks.

Many claim that buds will set better when the tips of the stocks have been cut off before the budding is done. It certainly looks reasonable, especially when the stocks are growing very rapidly and are full of thin watery sap, that such an operation would check the flow and therefore lessen the buds chances of being smothered or thrown out.

Eighty trees of row seven were used for this experiment. Ten stocks were budded after four or five inches of their tops had been clipped off. Ten others were also budded as a check. This operation was repeated at four different dates.

Results from this experiment show nothing:

Buds on stocks with tips cut off - - - - - 90% alive

Buds on stocks without tips cut off - - - - - 93.3% alive

The advantage of cutting off or pinching back the tips, however, is supposed to be obtained in very hot weather when growth is very rapid, and since no such weather occurred in this season we were not surprised at the outcome. In fact the summer was so cool that the stocks grew none too fast, and therefore the cutting off of the tips may even have been detrimental as indicated by the percentages.

V. Which Buds Are Best?

Which buds on the stocks are the best? Are the small buds at the butt of the stick as good as the larger, plumper ones along

Row 7

Typical
off check Typa
at off check at off check

Aug. 13

27

Sept. 3

the middle? Are the softer buds toward the tip of the stick equally good? Moreover, are buds which have no leaf stems as good as those so favored?

It is the general belief that buds along the middle of the stick are the best for budding purposes, and a considerable portion of each end--especially the tip end--is often cut off. But do we know this to be the case? Has it been established experimentally? In the case of an ear of corn it has been proved that the small grains at each end are just as good and will produce just as large and healthy stalks as the more perfect grains along the middle of the ear. They simply have a less amount of food stored up to start the young seedling, but when once started it is at no disadvantage. If the same conditions hold true in the case of the bud stick, even the objection of a small food supply which may lessen the young plant's chances in a dry season, will be removed, since if the bud once unites, plenty of food is available.

For this experiment I chose 50 trees on the end of Row 6. Buds were selected as follows:

1. Small buds at the butt of the stick (Plate 36 a). There are usually one or two and occasionally three of these undersized buds on a stick.

2. Buds taken from the tip of the stick--about two farther toward the end than one usually uses. These are about the same size as those toward the middle of the stick, but are usually softer



PLATE XXXVI.

(A) SMALL BUD FROM BUTT OF STICK;

(B) NORMAL BUD FROM MIDDLE OF STICK.

and not so well matured.

3. Buds normal in every respect from the middle of the stick (Plate 36 b)

4. Buds without leaf-stems. These were inserted carefully with the point of the knife, and injured as little as possible.

5. Check.

Results.

	Butts	Tips	Middle	No leaf stems	Check
% stand	100	100	90	100	100

All the buds of this experiment lived exceedingly well, and none of them showed anything unusual, except those taken from the butts and tips of the sticks. Five of the ten buds taken from the butts of sticks were just starting, and the other five showed a short and somewhat stunted growth. (Plate XXXVII.) Nine of those taken from the tips of sticks (the other one was broken off by the cultivator) were growing nicely, and would average almost twice as high as those taken from the butts (Plate XXXVIII.) This seems to indicate that the small undersized buds near the butt of the stick, although they unite well, ought not to be used, and that those toward the tip, even farther out than one usually goes, are as good as any buds on the stick--at least so far as growth goes.

VI. Northern or Southern Exposure?

Will a bud inserted on the north side of a tree live better



PLATE XXXVII.

STAND RESULTING FROM SMALL BUDS TAKEN FROM
BUTT END OF STICK.



PLATE XXXVIII.
STAND RESULTING FROM BUDS TAKEN FROM
TIP END OF STICK.

Budded Aug. 6.

Row 6

№. 1 2 3 4 5

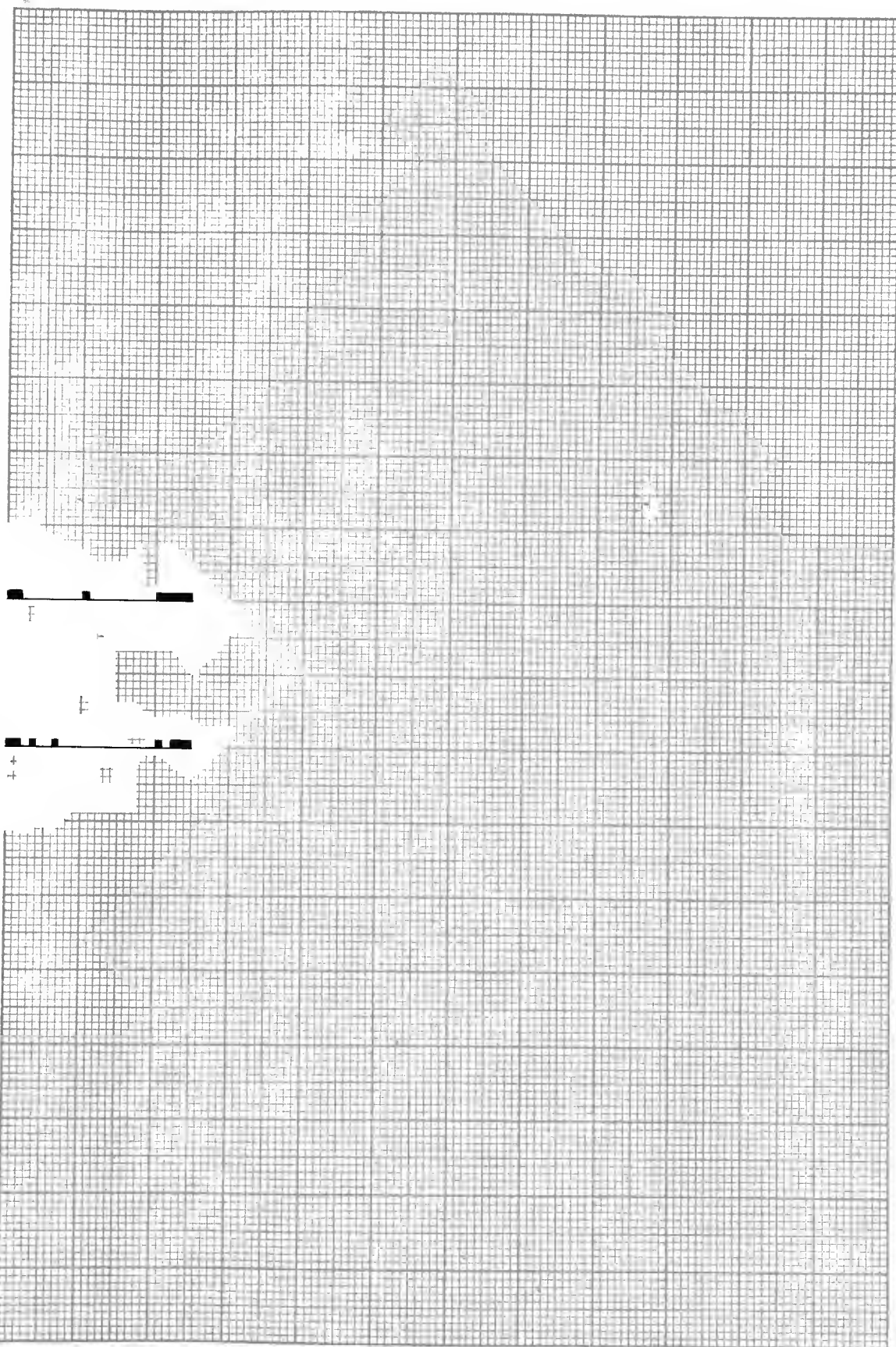
than one on the south side? Our text books say yes. When on the south side the bud is exposed to the direct rays of the sun, while on the opposite side it is shaded by the body of the tree. I have seen good stands on both sides, but once I noticed a very poor stand of buds on the south side which had been put in during very hot weather. Those inserted on the north side during the same period were also living poorly yet were better than the others. This would seem to indicate that in cool or even moderately warm weather, it does not make any material difference, but in hot sunny weather buds should be put on the north side.

I intended to do this experiment during a hot spell and get some definite knowledge on the subject. Unluckily, however, the hot spell did not arrive, and I was forced to go ahead and do the work on September 17. 80° was the maximum temperature that day. Twenty-five stocks were budded on the north side and an equal number on the south side.

Results.

	Northern exposure	Southern exposure
% stand	68	68

As was expected, on account of the cool weather and lateness of the season, no difference occurred in the percentage of buds inserted on the north and south sides of the stocks.



Row 4

Row 5

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VII. One or Two-Year-Old Sticks?

Is it best to use bud-sticks from two-year-old nursery trees, or are those taken from yearling trees equally good? This question, of course, applies only comparatively late in the season, since the buds of the one-year-old trees, if they have been properly cared for, are usually not sufficiently matured until the latter half of August.

Row 2 was used for this experiment. On August 27, 100 buds taken from two-year-old trees were put in, and an equal number of buds taken from one-year-old trees. This was repeated on September 3 with 25 buds each.

Results.

	Two-year buds	One-year buds
% alive first budding	81	74
% alive second budding	96	92
Average	88.3	83

This experiment shows that it is best to use buds taken from twoyear old trees.

VIII. Tying.

What is the best tying material? For this trial I used only the two materials which are chiefly employed--raffia and carpet warp. The former is much more commonly used than the latter.

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Row 8 was used for this experiment. 25 trees were tied with dry raffia, 25 with raffia that had been wet and then beaten out, and 25 with carpet warp. This was repeated at three different dates.

Results

	% stand from dry raffia	% stand from carpet warp	% stand from wet raffia
1st budding	92	88	88
2nd "	88	84	92
3rd "	88	92	92
Average	89.33	88	90.66

These percentages are too close to show any difference due to tying material. They might have been even closer had not one stock, which was tied with carpet warp, died before spring. The bud in this tree had united alright but, of course, had to be counted as dead. From this experiment it would seem that the two tying materials used are equally good. Nevertheless, I have heard several nurserymen, who have changed from raffia to carpet warp, say that they get better results with the latter.

IX. Mounding.

Should buds be protected during the winter by mounding or throwing up dirt to them; and, if so, should they be partly or entirely covered?

Another block of five rows was selected for this experiment.

The earth around 1, 2, and 3, was not disturbed. The soil around row 4 was thrown high up, entirely covering the buds. That around row 5 was thrown up to a considerable extent--about the height of the buds, covering some and leaving some uncovered, yet with the earth close around them.

Results.

The records of this experiment were lost, yet it could be seen that the row which had been mounded up highest, had a slightly better stand of buds than any of the others.

Summary.

1. No connection was found to exist between the temperature and the stand of buds secured for the season of 1904.
2. Rain appeared to have an injurious effect on the stand of buds inserted the same day.
3. Buds cut without any wood (ideal) lived better than those containing a little wood.
4. Buds from the smaller half of the stick lived slightly better than those from the butt half.
5. When other conditions are favorable, buds cut too thin or too thick may live as well as those properly removed.
6. Buds removed with a sliding cut lived better and made a more vigorous growth than those cut straight.
7. The length of the point of the bud did not affect the stand

8. Buds which had the top part of the shield removed showed only a 30% stand.

9. Shucked buds lived well, but not so good as those removed in the ordinary way.

10. Nothing was learned from the cultivation experiment.

11. No results were obtained from the clipping of the tops of the stocks.

12. The small buds taken from the butt of the stick lived as well as any others, but the growth made by them was poor.

13. Buds taken from the tip of the stick not only lived as well as any others, but made an especially fine growth.

14. Buds which had no leaf-stems showed no difference from the ordinary budding.

15. Buds set on the south side of the stock lived as well as those with a northern exposure.

16. Buds from two-year-old trees lived better than those from yearlings.

17. Practically no difference was found between the efficiency of raffia and carpet warp as tying material.

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